New Explorations to Hawking Radiation With Classical Theories

---- Part 4 of "New Concepts to Big Bang and Black Holes" [1][2]----

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Abstract: In part 1 and part 2 of **"New Concepts to Big Bang and Black Holes"** [1][2] (abbreviation is **NCBBBH**), it had been pointed out that, "the Hawking theory about BH (**Black Hole**) extricates the crisis of pure GTR (General Theory of Relativity) about Singularity in BH[2]", and "Just from Hawking theories of BHs, it has been known that BHs could always change its energy-matters with its surroundings[2]"**.** It has been a common knowledge that BHs can plunder energy-matters from outside with its very strong gravity, but almost nobody knows how to emit out Hawking radiation from BHs to outside. Normally, Hawking radiation may be formally explained with Uncertainty Principle of Quantum Mechanics, which recognized that a pair of virtual particles would be suddenly born out from vacuum, then annihilate and disappear at once [3]. The abstruse problems of that explanation are: why the energy gotten from BH by a fled particle is just equal to the energy of another one captured by BH and exactly equal to the energy of a particle (i.e. Hawking radiation) on the instable Event Horizon of any BH, in addition, the existence of so-called "particles of negative energy" has not had any observational evidence yet, and so-called "virtual energy" has not had a reliable numerical value right now in any theory and experiment. In this article, through calculations to different BHs with laws of classical theories, the characteristics of Hawking radiation may be firstly and better explained and exposed by classical theories. The important contribution of this article is to have truly discovered the secret of BHs to emitting Hawking radiations, i.e. any Schwarzchild BH might almost simultaneously emit 6 Hawking radiations together to outside from two opposite directions of 3 dimensions of itself. [Nature and Science. 2006;4(2):18-22].

Key Words: Hawking radiation, characteristics of Hawking radiation, checks to Hawking radiation with classical theories.

Introduction

Why could BHs, from which even lights had no way to escape out, emit Hawking radiation? What are the characteristics of Hawking radiation?

In this article, the calculated fundamental principles and formulas all come out from NCBBBH[1][2], i.e. originate from classical theories (GTR, Hawking theory about BH and thermodynamics etc). Through further detailed calculations and qualitatively analyses to three following different real gravitational BHs already studied in NCBBBH, the characteristics of Hawking radiation may be more easily exposed and conceived with classical theories.

(i). BHs of (m_t $=10^{-5}$g)[1][2]: From part 1 of NCBBBH, it can be seen that, all BHs of (m_t = 10^{-5}g) **were minimum gravitational BHs (MGBH)**. They only appeared at the genesis of our universe and formed our present universe. They would be impossible to appear again in all lifetime of our universe.

(ii). BHs of ($m_{om} \approx 10^{15}$g)[2]: In part 2 of NCBBBH, any BH of (m_t = 10^{15}g) is a mini BH and has only existed in star-formed BH. **They are all middle-sized BHs.**

(iii). BH of (M_u = 10^{56}g)[1][2]: In part 1 and 2 of NCBBBH, BH of (M_u = 10^{56}g) is a real **maximum BH**, which is just our present universe.

1. Formulas for calculating parameters of real gravitational black holes (RGBH)

Only Schwarzchild's BHs (no charges, no rotating and spherical symmetry) will be studied in this article below.

$R_b=2GM_b/C^2$, or $C^2=2GM_b/R_b$ [1][2] (1a)

According to GTR, (1a) is the necessary condition for existence of any RGBH.

According to Hawking formulas about BH,

$T_b = (C^3/4GM_b) \times (h/2\pi\kappa) \approx 0.4\times10^{-6}M_\theta/$
$\approx 0.8\times10^{27}/ M_b$ (k) [4][1][2] (1b)

$\tau_b \approx 10^{-27} M_b^3$ (s) [4][1] [2] (1c)

Other formulas are cited below:

$E_1 = m_pC^2$, $E_2 =\kappa T$, $E_3 = Ch/\lambda$ (1d)

$M_b = 4\pi\rho_b R_b^3/3$ (1e)

$R_b = 3h/(2\pi Cm_s)$[2] (1f)

For any formed RGBH i.e. **Schwarzchild's BH**, its various parameters in above formulas are below: if M_b—mass of a formed RGBH, then, R_b —its Schwarzchild's radius, T_b—temperature on Event Horizon, ρ_b --density on Event Horizon, G--gravitational constant, κ-- Boltzmann's constant, h—Plank's constant, C—light speed, m_{sr}—mass of Hawking radiation emitted out from BH, m_s—mass of a particle in BH, τ_b—lifetime of a RGBH, E_1—energy of mass m_p, E_2 –energy of a particle, E_3 – energy of a radiation, λ--wavelength of a radiation, ν --frequency of a radiation.

For convenient calculation, formula (1a) can be altered into:

$M_b/R_b = C^2/2G \approx 0.675\times10^{28}$g/cm (1aa)

2. The further analyses and modification to formula (1f) -- $R_b = 3h/(2\pi Cm_s)$

Formula (1f) above comes from formula (13bd), which is derived in section (B) of paragraph 13 in part 2 of NCBBBH according to the balance between the central gravity of a BH and its heat pressure to a particle m_s at any point in a BH. **In this article, m_{sr} are only defined on or closely linked to Event Horizon (boundary) of any BH, (m_{sr} =** m_s) is just on Event Horizon, they may be conceived either in mass of a particle or in equivalent mass of radiation owing to the duality of waves and particles. In the process to derive formula (1f) in NCBBBH, m_s had been supposed to be a single particle. However, in reality, m_s might be the sum of ($m_s = n\times m_{sr}$) emitted out simultaneously as Hawking radiations from Event Horizon (boundary). m_{sr}—a radiation on Event Horizon,

Suppose $m_s = n\times m_{sr}$, and let $n = 6$ (2a)

From (1f) and (2a)

$\mathbf{R_b m_{sr} = h/(4\pi C)}$ **(2b)**

Why would let n = 6? Let's look back to formulas (5e) and (5g) in paragraph 5 of part 1 of NCBBBH,

From (5e), $m_p = (hC/8\pi G)^{1/2} = 10^{-5}$g [6][1]

From (5g), $l_p = t_p\times C = (Gh/2\pi C^3)^{1/2}$ [6][1]

In (5g), t_p is Plank time, so, m_p is analogous to m_{sr}, and l_p is analogous to R_b.

As a result, $m_p\times l_p = h/(4\pi C)$ (2c)

Thus, (2b) ≡ (2c)

Therefore, it can be seen from formulas (1f) and (2b) or (2c), on Event Horizon of a BH, **a real m_{sr} is solely confined by R_b i.e. M_b of a BH.**

$\mathbf{M_b m_{sr} = hC/(8\pi G) = 1.187\times10^{-10}gg}$ **(2d)**

From (2d), in case M_b is a given value, m_{sr} on Event Horizon is thus gotten an exact value. Correspondingly, from formula (1d),

$m_{sr} = \kappa T_b/C^2 = h/C\lambda_{sr} = h\nu_{sr}/C^2$ (2e)

(i).If $m_s > m_{sr}$, hence, $M_b m_s > 1.187\times10^{-10}$gg: m_s is either the mass of a particle or the equivalent mass of radiation in BH. $m_s > m_{sr}$ is showed that, m_s is heavier than m_{sr}, i.e. $m_s = \kappa T_s/C^2$ ($T_s > T_b$), or $m_s = h/C\lambda_s$ ($\lambda_s < \lambda_{sr}$), so, m_s can only exist inside Event Horizon and has no way to flee out from Event Horizon.

(ii). If $m_s < m_{sr}$, $M_b m_s < 1.187\times10^{-10}$gg: m_s cannot exist inside BH. **In reality, particles and radiations of ($m_s < m_{sr}$) would be impossible to exist in any BH, because all BHs were formed at the state of extremely high energy and temperature.** If by any chance some $m_s < m_{sr}$ appeared in a BH, they would flee out from Event Horizon as Hawking radiation.

(iii).If $m_s = m_{sr}$, $M_b\ m_s = M_b m_{sr} = 1.187\times10^{-10}$gg, what will happen? In reality, energy of m_{sr} either as a moving particle or as a vibrant radiation would not have an exact same value, but only have an instantaneous value at any instant, because m_{sr} certainly has **energy-fluctuation** on or closely linked to Event Horizon. Any tiny decrease in instantaneous temperature and in kinetic energy of m_{sr} at state of the lowest energy would lead increase in its tiny potential energy and decrease in R_b. Conversely, a little instantaneous smaller R_b would let more reduction of kinetic energy of m_{sr} and finally let m_{sr} flee out from Event Horizon. That is the real reason why all BHs could emit energy-matters to outside and shrink its size. That is a reasonable explanation to Hawking radiation with classical theories.

3. More calculations and further analyses

(i). Suppose n_i are total numbers of particles and radiations in a BH of M_b, so,

$\mathbf{n_i = M_b / m_{sr} = M_b C^2/\kappa T_b}$ **(3a)**

A. To $m_t = 10^{-5}$g:

$n_i = m_t / m_{sr} = 10^{-5}/1.187\times10^{-5} = 0.89 \approx 1$

$n_i = m_t C^2/\kappa T_b = 10^{-5}\times9\times10^{20}$

$/(1.38\times10^{-16}\times0.8\times10^{32}) = 0.815 \approx 1$

B. To $m_{om} = 10^{15}$g:

$n_i = m_{om}/m_s = 10^{15}/(1.187\times10^{-25}) = 0.84\times10^{40}$

$n_i = m_{om} C^2/\kappa T_b = 10^{15}\times9\times10^{20}$

$/(1.38\times10^{-16}\times0.8\times10^{12}) = 0.813\times10^{40}$

C. To $M_u = 10^{56}$g:

$n_i = M_u/m_s = 10^{56}/(1.187\times10^{-66}) = 0.84\times10^{122}$

$n_i = M_u C^2/\kappa T_b = 10^{56}\times9\times10^{20}$

$/(1.38\times10^{-16}\times0.8\times10^{-29}) = 0.815\times10^{122}$

The same results (values) of n_i calculated with two different formulas in three BHs clearly shows that, all theories and laws, especially (2d) about BHs applied in this article are almost fully correct.

(ii). λ_{sr}--Wavelength of radiation m_{sr} on or closely linked to Event Horizon, ν_{sr}—frequency of radiation m_{sr},

From (2e), $\lambda_{sr} = h/(m_{sr}C) = C/\nu_{sr}$ (3b)

In case $m_{sr} \approx 10^{-5}$g, $\lambda_{sr} = 2.2\times10^{-32}$cm

In case $m_{sr} = 1.187\times10^{-25}$g, $\lambda_{sr} = 1.86\times10^{-12}$cm

In case $m_{sr} \approx 1.187\times10^{-66}$g, $\lambda_{sr} = 1.86\times10^{29}$cm

(iii). From formula (1c), $\tau_b \approx 10^{-27} M_b^3$ (s),

$$\mathbf{d\tau_b \approx 3\times10^{-27} M_b^{2}\, dM_b} \quad \textbf{(3c)}$$

Let dM_b = one m_{sr}, hence, $d\tau_b$ is the needed time of emitting a Hawking radiation m_{sr}.

To $m_t = 10^{-5}$g, $d\tau_b \approx 3\times10^{-42}$s

To $m_{om} = 10^{15}$g, $d\tau_b \approx 3.6\times10^{-22}$s

To $M_u = 10^{56}$g, $d\tau_b \approx 3.6\times10^{19}$s $\approx 10^{12}$yrs

4. Some other more important conclusions

Table 1. m_t, m_{om}, M_u, formulas

	m_t	m_{om}	M_u	formulas
mass of BH,	10^{-5}g	10^{15}g	10^{56}g	
R_b (cm)	1.5×10^{-33}	1.5×10^{-13}	1.5×10^{28}	(1aa)
T_b (k)	0.8×10^{32}	0.8×10^{12}	0.8×10^{-29}	(1b)
τ_b (s, yrs)	10^{-42}s	10^{10}yrs	10^{133}yrs	(1c)
ρ_b (g/cm^3)	7×10^{92}	7×10^{52}	7×10^{-30}	(1e)
m_{sr} (g)	1.187×10^{-5}	1.187×10^{-25}	1.187×10^{-66}	(2d)
ni	1	10^{40}	10^{122}	(3a)
λ_{sr} (cm)	2.2×10^{-32}	1.86×10^{-12}	1.86×10^{29}	(3b),(4a)
$d\tau_b$	3×10^{-42}s	3.6×10^{-22}s	10^{12}yrs	(3c)
ν_{sr} (s^{-1})	1.4×10^{42}	1.6×10^{22}	1.6×10^{-19}	(4b)
ν_r (s^{-1})	0.3×10^{42}	0.28×10^{22}	0.28×10^{-19}	(4c)

Values listed in Table 1 above are results calculated according to all relative formulas.

(i). From formulas (2b) and (3b),

$$\boldsymbol{\lambda_{sr} = 4\pi R_b} \quad \textbf{(4a)}$$

Formula (4a) above indicates:

In case any radiations m_s of ($\lambda_s < 4\pi R_b$) in BH, they had no chance to flee out from BH.

In case any radiations m_s of ($\lambda_s > 4\pi R_b$), it had no chance to exist in BH.

In case a radiation m_{sr} of ($\lambda_{sr} = 4\pi R_b$), it only was at the state of the lowest energy (i.e. trough) to have the chance to flee out from BH through Event Horizon as Hawking radiation. Moreover, the **Event Horizon of any BH is not a rigid shell**, **but a virtual spherical surface with radius R_b**, it cannot obstruct radiations m_{sr}, which energy are locating at the trough of energy-fluctuation, to go away easily from Event Horizon. That is the real reason for any BH to emit Hawking radiation and then to shrink its size R_b. Otherwise, BHs would be eternal monstrosities in nature.

Thus, emitting Hawking radiation is only the spontaneous action of any BH and is the inevitable outcome caused by the regulative motion of matter in any BHs, it cannot be either stopped, induced or brought by any exterior natural forces. **Therefore, no matter whether a pair of "virtual particles" in vacuum would come out or not, all BHs could emit their Hawking radiations as usual.**

Checking up values of R_b and λ_{sr} on Table 1, it can be clearly seen that formula (4a) is fully right.

(ii). Owing to emitting Hawking radiations m_{sr} and even **energy-fluctuation of** m_{sr}, the Event Horizon (R_b) of any BH would always cause a shrink frequency ν_r. The coincidence between shrink frequency ν_r of R_b and vibrant frequency ν_{sr} of radiations m_{sr} is analogous to some resonance and is more beneficial to m_{sr} at the state of the lowest energy to flee out as Hawking radiations.

Let ν_{sr} = frequency of m_{sr} on Event Horizon,

$\nu_{sr} = C/\lambda_{sr}$ (4b)

To $m_t = 10^{-5}$g, $\nu_{sr} = 1.4\times10^{42}$s^{-1}

To $m_{om} = 10^{15}$g, $\nu_{sr} = 1.6\times10^{22}$s^{-1}

To $M_u = 10^{56}$g, $\nu_{sr} = 1.6\times10^{-19}$s^{-1}

Let ν_r = shrink frequency of R_b due to emitting a single m_{sr}.

From formula (3c), $d\tau_b$ is the needed time to emit a single m_{sr}, then, $\nu_r = 1/ d\tau_b$,

$$\boldsymbol{\nu_r = 1/ d\tau_b = 1/3\times10^{-27} M_b^2 m_{sr}} \qquad \textbf{(4c)}$$

To $m_t = 10^{-5}$g, $\nu_r = 0.3\times10^{42}$
To $m_{om} = 10^{15}$g, $\nu_r = 0.28\times10^{22}$
To $M_u = 10^{56}$g, $\nu_r = 0.28\times10^{-19}$

Comparing calculated values above between ν_{sr} of (4b) and ν_r of (4c), it can be seen that,

$\nu_{sr} = n\,\nu_r = 6\,\nu_r$, n = 6, (4e)

From formula (4c), ν_r just indicates that, shrink frequency ν_r of R_b only cause from a single Hawking radiation m_{sr} emitted out from BH. However, from formulas (2a), (2b) and (2d), it is defined that, any BH would simultaneously emit 6 m_{sr} together, but not a single m_{sr}. Thus, in formula (4c), the value of ν_r gotten by emitting a single m_{sr} in time of $d\tau_b$ should be changed by 6 m_{sr} simultaneously emitted together in the same time of $d\tau_b$, so, a new shrink frequency ν_r' of R_b should become $\nu_r' = 6\,\nu_r = \nu_{sr}$. Thus, formula (4e) is still right, and on Table 1, values of ν_{sr} are just equal to values of $(6\times\nu_r)$.

Schwarzchild's BH is a perfect ball-body; it would have many radiations with the same frequency on or closely linked to Event Horizon, they could simultaneously flee out together at the state of their instantaneously lowest energy. Therefore, **Hawking radiations originated from resonance between emitting ($n\times m_{sr}$) Hawking radiations from BH and shrinkage of Schwarzchild's radius R_b with emissions of Hawking radiations**.

Under the condition of emitting n Hawking radiations (i.e. $n\times m_{sr}$) together, let λ_{srn}—a pretended overlapped wavelength of $(n\times m_{sr})$, so,

$\lambda_{srn} = \lambda_{sr}/n$ (4f)

From (2b), (3b) and (4a),

$\boldsymbol{\lambda_{srn} = 4\pi R_b/n}$ **(4g)**

In case n = 6, $\lambda_{srn} = 2\pi R_b/3 \approx 2R_b$ (4h)

(iii). When a BH took in energy-matters or emitted out Hawking radiations, its R_b would have some increase or decrease. Correspondingly, λ_{sr} of radiations in BH would be changed a little more, because **$d\lambda_{sr} = 4\pi dR_b$, it is just red shift caused by gravity.** The change ($d\lambda_{sr}$) of λ_{sr} of a radiation is linear, but the change (dR_b) of R_b for a BH may indicate the change of spherical surface of a BH.

(iv). On Table 1, at M_u column, on Event Horizon of our universe, $m_{sr} = 1.187\times10^{-66}$ g, its $\lambda_{sr} = 1.86\times10^{29}$ cm, probably, m_{sr} might be gravitons to have been sought by scientists for many decades, if gravitons would have really existed all the time.

(v). The explorations to mysterious number "6" appeared in this article

The mysterious number "6" has appeared in this article many times and will be studied below.

In formula (2a), n = 6. It means that, any BH would simultaneously emit 6 Hawking radiations m_{sr} together. (2b) = (2c) and the correctness of same values of n_i calculated from (3a) have showed that (n = 6) is undoubtedly right and convincing.

In formula (4e), n = 6. In calculated values of all other BHs except minimum BH of ($m_t = 10^{-5}$g), ($\nu_{sr} = 6\nu_r$) are right, it means that, **shrinkage of R_b come from 6 m_{sr} emitted together by a BH at the same time.** In reality, emission of 6 m_{sr} would hardly be realized at a really exact same instant, and would be always a little former or later, then, R_b would certainly shrink 6 times in the same period $d\tau_b$ with emitting 6 m_{sr}, thus, the shrink frequency ν_r of R_b should become ($6\nu_r = \nu_{sr}$). The correctness of values of ($6\nu_r = \nu_{sr}$) on Table 1 has fully proved that, formulas (4c) and (4b) originated from different theories can get a same result. However, minimum BH of ($m_t = 10^{-5}$g) is a solely exception, its $\nu_{sr} \neq 6\,\nu_r$, because the upshot of minimum BH as a single particle without 6 m_{sr} would be a smashing explosion.

In formulas (4g) and (4h), in case n = 6, the pretended overlapped wavelength λ_{srn} of 6 Hawking radiations m_{sr} is equal to $2\pi R_b/3 \approx 2R_b$.

The above same result of (n = 6) from many different formulas (2b),(2c),(3a) and (4e) appeared in above conditions many times precisely indicate that, **any BHs except minimum BH of ($m_t = 10^{-5}$g) would always simultaneously emit out (n = 6) Hawking radiations together as to keep some resonance between Hawking radiations emitted by BH and shrinkage of R_b, as to let Hawking radiations have opportunity to flee out at the state of the smallest instantaneous energy from Event Horizon of any BH.**

Why must any BH always simultaneously emit 6 Hawking radiations? Any Schwarzchild BH is a spherical-symmetrical body; for keep the balance and stability of a BH at emitting Hawking radiations in all time, any BH must symmetrically and almost simultaneously emit out 6 Hawking radiations together to two opposite direction of 3 dimensions of itself.

The further verification to emitting 6 m_{sr} together from BH: if all calculated values about (n = 6) have no any mistakes, those values should precisely accord with following formula.

$m_{sr}C^2 = \kappa T_b$ (4i)

To $m_t = 10^{-5}$g, $m_{sr}C^2 = 9\times10^{15}$, $\kappa T_b = 11\times10^{15}$
To $m_{om} = 10^{15}$g, $m_{sr}C^2 = 1.07\times10^{-4}$, $\kappa T_b = 1.1\times10^{-4}$
To $M_u = 10^{56}$g, $m_{sr}C^2 = 1.07\times10^{-45}$, $\kappa T_b = 1.1\times10^{-45}$

(vi). The further analyses to minimum BH of (m_t $=10^{-5}$g)

From formula (2d), $M_b m_{sr} = hC/(8\pi G) = 1.187\times10^{-10}$gg, it can be seen that, ($m_t \approx 10^{-5}$g $\approx$ m_{sr}) is just a result of approximate calculation. The precise calculations and analyses are cited below.

Formula (2d) is deduced from (2a), i.e. m_{sr} in (2d) is just one of 6 m_{sr} emitted from a BH at the same time. Thus, to the minimum or final BHs of ($m_t \approx 10^{-5}$g), there are only two possible results.

First. If $M_b = 6\ m_{sr}$, from (2d), $M_b^2 = 6hC/(8\pi G) = 6\times1.187\times10^{-10}$gg $= 7.122\times10^{-10}$g g, so,

$M_b = 2.667\times10^{-5}$g, $m_{sr}=M_b/6=0.445\times10^{-5}$g (4j)

Formula (4j) expresses that, minimum BH of ($M_b = 2.667\times10^{-5}$g) is completely composed by 6 Hawking radiations of ($m_{sr} = M_b/6 = 0.445$g). Its final fate either might violently explode as Hawking radiations or further collapse into a whole minimum BH of ($M_b = 2.667\times10^{-5}$g).

From formula (3a), $n_i = M_b / m_{sr} = M_b C^2/\kappa T_b$

$M_b / m_{sr} = 2.667\times10^{-5}\text{g}/0.445\times10^{-5}\text{g} = 6$

$M_b C^2/\kappa T_b = 2.667\times10^{-5} C^2/(\kappa\times0.3\times10^{32}) = 5.7$

Verifications: $m_{sr}C^2 = 4.05\times10^{-15}$, $\kappa T_b = 4.1\times10^{-15}$

Second. Above whole minimum BH of ($M_b = 2.667\times 10^{-5}$g) would just be a single particle of the highest energy. Thus, all BHs of ($M_b=2.667\times10^{-5}$ g) could only violently explode at the highest temperature of 10^{32}k only appeared at the genesis of our universe.

Verifications: $m_{sr}C^2 = 24\times10^{-15}$, $\kappa T_b = 4.1\times10^{-15}$

Two different results of minimum BH ($M_b = 2.667\times 10^{-5}$g) above might have more important significance to the evolution of our universe at its genesis, but hardly exert any influence to calculated values and conclusions in this article.

It displays from calculated values that, the first result seems more correct than the second one.

(vii). In this article, many new formulas, (2b), (2d), (3a), (4a), (4c) and (4g) have been derived out. All calculated values on Table 1 have exactly proved that, the **macroscopical explanations to all characteristics of BHs, included Hawking radiation, with classical theories and formulas are surely effective, correct and identical.** The observational evidences and examinations to (2b), (2d), (4a) and (4g) will be remained in future.

(viii). **In future, examinations of correctness to formula (2d) may be easier taken. Once the correctness of formula (2b) could be checked up by observational evidences, all classical theories and formulas applied in this article and in NCBBBH as a complete system to macroscopically solve problems about BHs would be reliably verified.**

----The End----

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References

[1] Dongsheng Zhang: New Concepts to Big Bang And Black Holes—Both Had No Singularity at All (Part 1).

[2] Dongsheng Zhang: New Concepts to Big Bang And Black Holes—Both Had No Singularity at All (Part 2). Two articles above were published on magazine "Nature and Science", 2(3), 2(4),3(1), or debate-001, 2004, ISSN:1545-0740, Published by Marsland Company, P. O. Box 753, East Lansing, Michigan, MI 48826 U.S.A. Or http://www.sciencepub.org/nature/debate-001 http://www.sciencepub.org/nature/0203 and 0204 http://www.sciencepub.org/nature/0301.

[3] John & Gribbin: Companion to The Cosmos, ISBN 7-5443-0145-1, Hainan Publishing House, China, 2001, 9.

[4] Wang, Yong-Jiu: Physics of Black Holes; Hunan Normal University Publishing House, China. 2000.

[5] Formula (13bd) in Part 2 of NCBBBH i.e. [2].

[6] He, Xiang-tao: Observational Cosmology. Science Publishing House. Beijing, China. 2002.